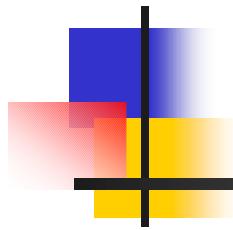
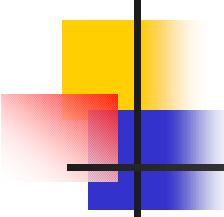


LQ search in evjj channel



Simona Rolli (TUFTS)

-Preblessing-



Introduction

- Some beyond the SM models assume additional symmetry between leptons and quarks
- LeptoQuarks – transition between leptons and quarks
 - Have both lepton and baryon numbers
 - λ - unknown coupling to leptons and quarks

LQ production at the TeVatron

■ Production

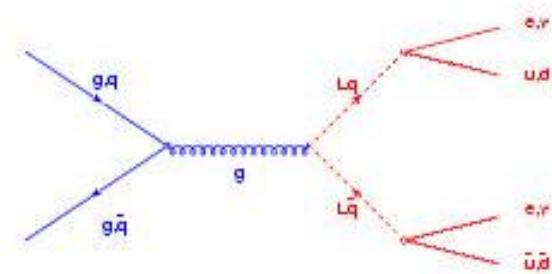
- $qg \rightarrow LQ + L\bar{Q}$
- $gg \rightarrow LQ + L\bar{Q}$
- $q\bar{q} \rightarrow LQ + L\bar{Q}$

■ Decay

- $LQL\bar{Q} \rightarrow l^+l^-q\bar{q}, l^\pm n\bar{q}q, nn\bar{q}\bar{q}$ $\beta = \text{Br}(LQ \rightarrow eq)$

■ Experimental signature:

- High pt isolated leptons (and/or MET) + jets



LQ production at TeVatron

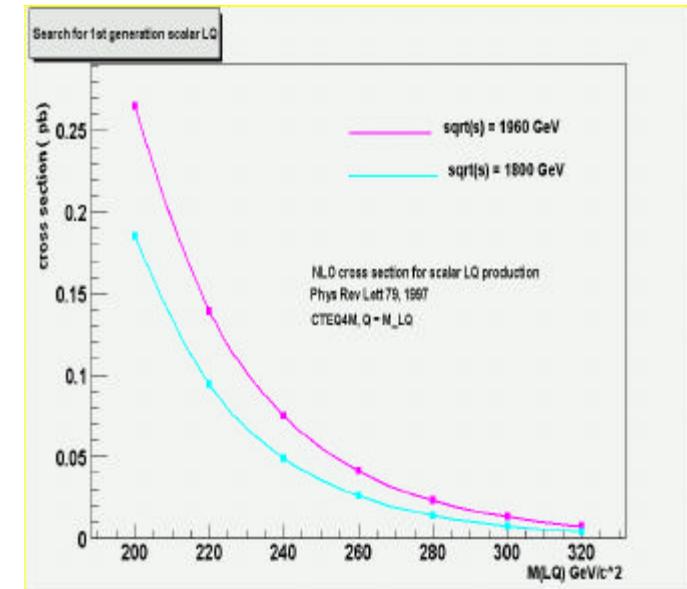
Code from Michael Kraemer (Phys.Rev.Lett 79,1997)

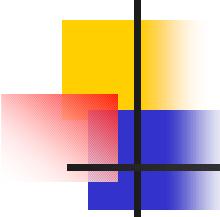
M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.185E+00
220	0.094E+00
240	0.489E-01
260	0.259E-01
280	0.138E-01
300	0.746E-02
320	0.401E-02

M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.265E+00
220	0.139E+00
240	0.749E-01
260	0.412E-01
280	0.229E-01
300	0.129E-01
320	0.727E-02

$\sqrt{s} = 1800 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf

$\sqrt{s} = 1960 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf





Previous results from Run I

- Cdfnote 4228 - July 1997
 - $m(LQ) > 180 \text{ GeV}/c^2$
 - straightforward strategy
 - cut on transverse mass to get rid of $W + 2$ jets background
- Cdfnote 4873 - June 2001
 - $m(LQ) > 182 \text{ GeV}/c^2$
 - relative likelihood technique

LQ search in evjj

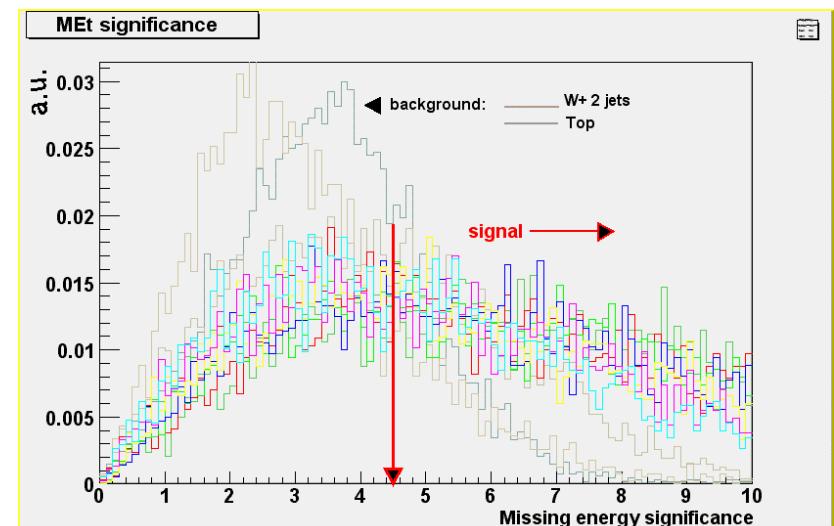
Signature: 1 electron, 2 jets and large MET

Analysis cuts

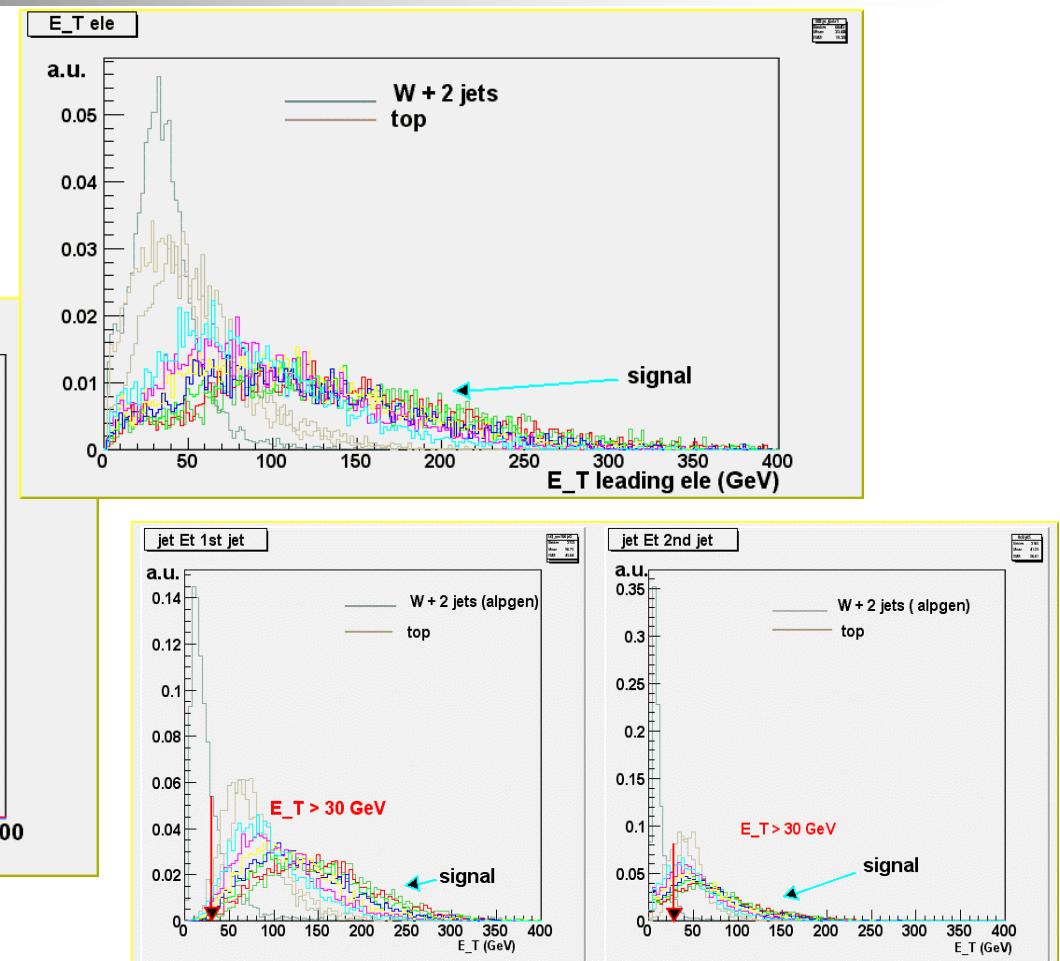
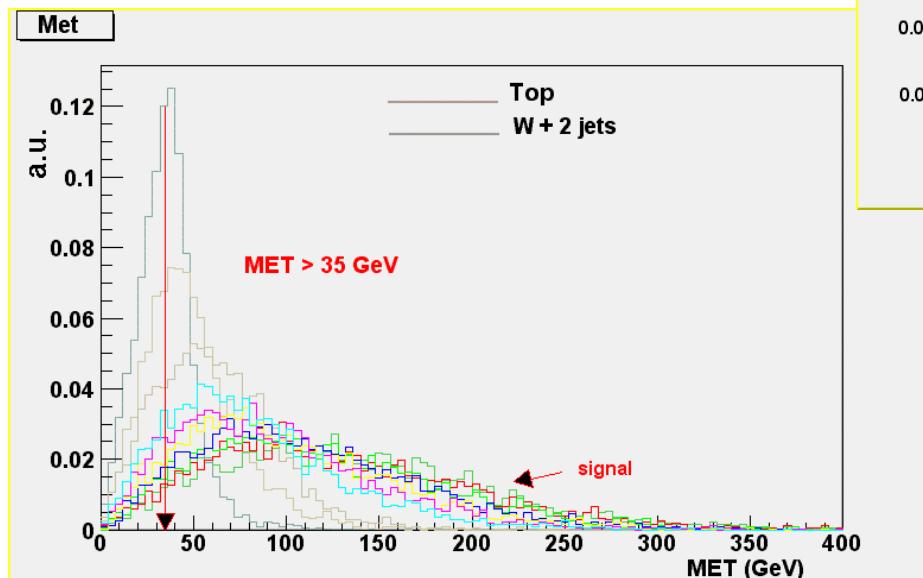
- 1 central electrons with $E_T > 25$ GeV and $\text{MET} > 35$ GeV
- 2 jets with $E_T > 30$ GeV
- $\Delta\phi(\text{MET-jet}) > 10^\circ$
- $E_T(j1) + E_T(j2) > 80$ GeV
- $M_T(e-\nu) > 120$
- $\text{Met}/\sqrt{\sum E_T} > 4.5$

similar to note 4228, but for metSig cut

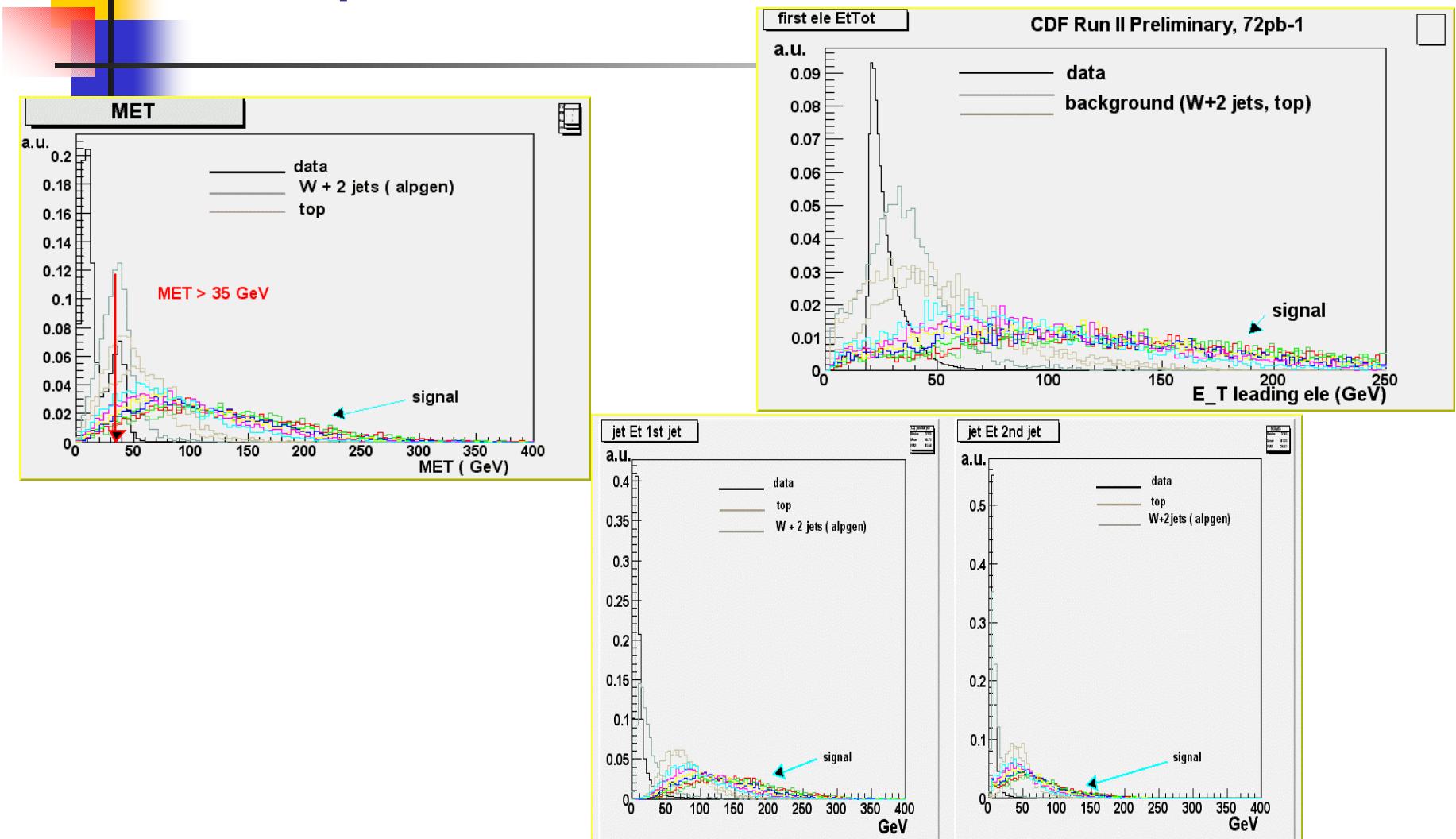
Events with 2 central electrons are rejected
(to be orthogonal to eejj analysis)



MC distributions

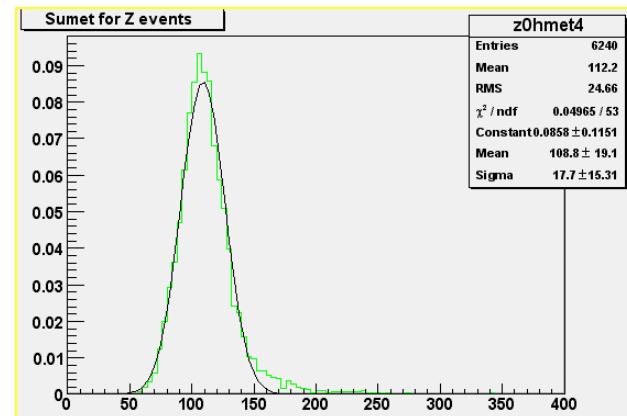
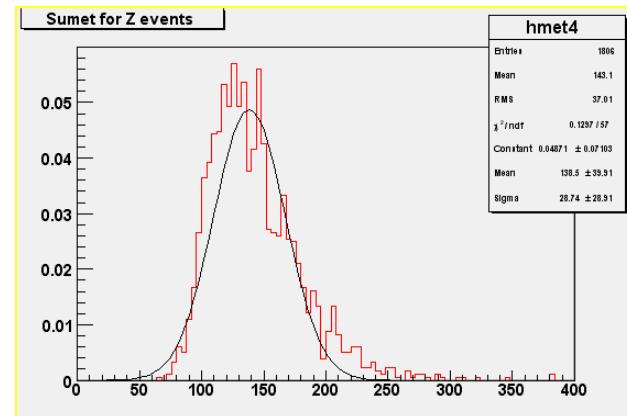


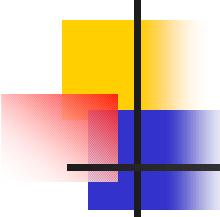
Comparison with data



Sumet and Met

- Sumet from data (Z^0 events) is larger than MC (Pythia DY)
- LQ efficiencies calculated scaling Sumet by the difference between data and MC
- MET has been “corrected” after correcting the jet energies

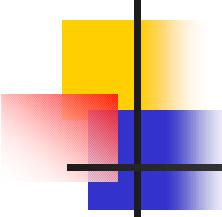




Tools

- Signal generated and reprocessed with 4.9.1
 - 5000 events at masses from 160 to 280
 - run number 151435
 - full beam position
 - talk GenPrimVert
 - BeamlineFromDB set false
 - sigma_x set 0.0025
 - sigma_y set 0.0025
 - sigma_z set 28.0
 - pv_central_x set -0.064
 - pv_central_y set 0.310
 - pv_central_z set 2.5
 - pv_slope_dxdz set -0.00021
 - pv_slope_dydz set 0.00031
 - exit
- eN (4.9.1)used for ntuple analysis
 - <http://ncdf70.fnal.gov:8001/talks/eN/eN.html>

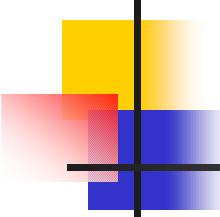
Same as cdf6338



Efficiencies & acceptance

$$\epsilon_{\text{tot}} = \epsilon_{\text{Acc}}(M) \times \epsilon_{\text{ID}} \times \epsilon_{z0} \times \epsilon_{\text{trig}}$$

- Trigger
 - Top/EW - as in Z' analysis we use $99.1 \pm 0.1\%$
- Efficiencies for electron selection cuts
 - Z' analysis
 - $\epsilon_T = 89.6 \pm 0.5$
- Other
 - efficiency on the vertex cut ($|z_0| < 60$ cm) 95.2 ± 0.1 (stat) ± 0.5 (sys) (Willis Sakumoto)



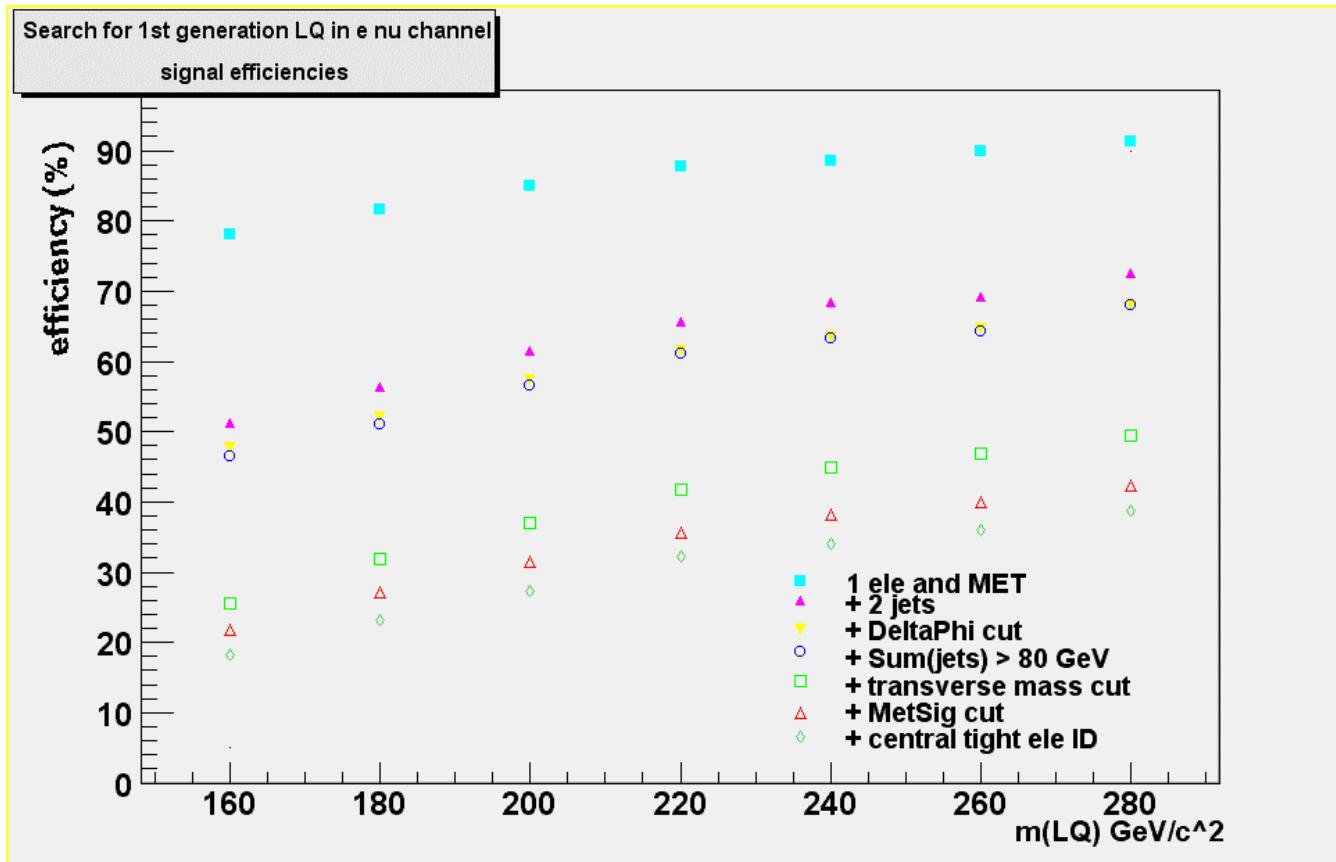
Electron ID (Z' analysis)

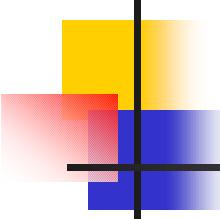
- Central electron tight

- $E_t \geq 25 \text{ GeV}$
- $p_t > 10 \text{ GeV}$
- $\text{hadem} \leq 0.055 + 0.00045 * E$
- $E/p < 4$ (for $E_T < 200 \text{ GeV}$)
- $\text{iso4e}/\text{emet} < 0.1$ (0.2 for second central loose)
- $|\Delta x| < 3.0$
- $|\Delta z| < 5.0 \text{ cm}$
- Fiducial = 1
- $I_{\text{sh}} < 0.2$

$$\varepsilon_T = 89.6 \pm 0.5\%$$

Total acceptance

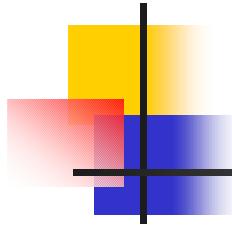




Expected signal events

Number of expected events in 72 pb⁻¹

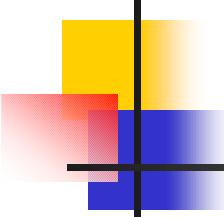
Mass (GeV/c ²)	n Theory CTEQ4M (pb)	n Theory CTEQ4M (pb)
	$Q^2 = M_{LO}^2/4$	$Q^2 = 4M_{LO}^2$
160	7.1	6.2
180	4.8	3.8
200	2.8	2.3
220	1.7	1.4
240	0.99	0.8
260	0.6	0.5
280	0.34	0.3



Background

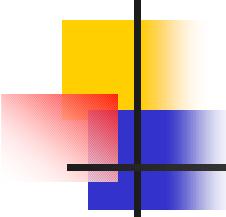
- tt with both $W \rightarrow e\nu$ 0.34 ± 0.04 events
 - pythia
- tt decaying into l + jets 0.03 ± 0.01 events
 - pythia
- W + 2 jets
 - alpgen + PS 1.6 ± 0.8 events

Total	1.9 ± 1.3
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Data sample

- btop0g (inclusive electrons) stripped from bheI08 and (4.8.4 Production)
- Inclusive-ele_484_REMAKE
- events selected from Ele_18 && Ele_70 triggers
- good runs from March 23 2002 to Jan 12 2003 (141544 - 156487)
- $70.2 \text{ pb}^{-1} \times 1.019$
 - 1 isolated electrons
 - One tight (central)
 - MET $> 35 \text{ GeV}$
 - At least 2 energetic jets



Data sample

```
module clone Prereq HPTE
module enable Prereq-HPTE
module talk Prereq-HPTE
L1Accept set true
L2Accept set true
L3Accept set false
L3TriggerNames set ELECTRON70_L2_JET \
                 ELECTRON_CENTRAL_18 \
                 ELECTRON_CENTRAL_18_NO_L2 \
                 W_NOTRACK \
                 W_NOTRACK_NO_L2 \
                 Z_NOTRACK
debug set false
exit
exit
```

```
module clone StripSingleE HPE2
module enable StripSingleE-HPE2
module talk StripSingleE-HPE2
elePtMin set 15.0
etCalMin set 70.0
delXMin set 3.0
delZMin set 5.0
show
exit
```

```
module clone StripSingleE HPE1
module enable StripSingleE-HPE1
module talk StripSingleE-HPE1
elePtMin set 9.0
etCalMin set 18.0
delXMin set 3.0
delZMin set 5.0
EoPMax set 4.0
lshrMax set 0.3
hademMax set 0.125
show
```

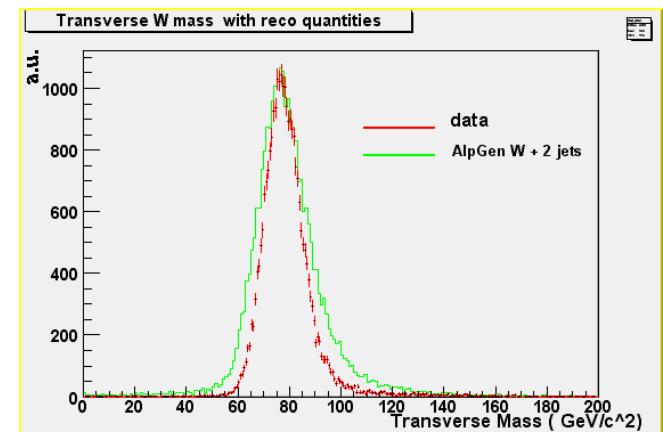
W cross section

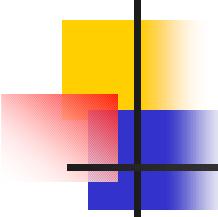
Relaxing the MET cut to 25 GeV we obtain 44510 candidate W events

Assuming the same background expectation as in CDF6300 (scaled to the increased Luminosity) we obtain:

$$\sigma \text{Br}(W \rightarrow e\nu) = (N_Z - N_{\text{BG}}) / (A_W \cdot e_{\text{ID}} \cdot e_{\text{trig}} \cdot e_{z_0} \cdot L) = \\ 2.93 \pm 0.01 \text{ (stat)} \pm 0.13 \text{ (sys)} \pm 0.27 \text{ (lumi)} \text{ nb}$$

Acceptance	$24.6 \pm 0.04 \pm 1.05 \text{ (sys)}\%$
ID efficiency	$86.42 \pm 0.5\%$
trigger efficiency	$99.9 \pm 0.1\%$
z_0 efficiency	$95.2 \pm 0.5\%$
Observed events	44510
estimated bkg	$2590 \pm 100 \text{ (stat)} \pm 900 \text{ (sys)}$
integrated L	72.0 ± 0.45

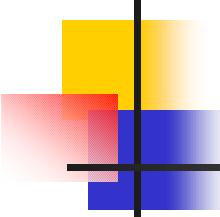




Analysis results

0 events survive the analysis cuts:

Number of events with 1 ele > 25 && MET > 35	26413
evt with 1 ele, MET and \geq 2 jets (30 30)	224
evt with 1 ele, MET and \geq 2 jets and dphi cut	176
evt with 1 ele, MET and \geq 2 jets and dphi cut and 2jet_80	136
evt with 1 ele, MET and \geq 2 jets and dphi cut and 2jet_80 and T mass cut	23
evt with 1 ele, MET and \geq 2 jets and dphi cut and 2jet_80 and T mass cut and metsig 1	



Surviving event

Run number = 143980, Event number = 3789228
(28 April 2002, no Si good run list)

Met significance = 4.31371

MET = 63.7017

Corrected Met significance = 4.51987

Corrected MET = 66.7461

ele Et = 77.7476

after Jet corrections

Et first jet = 57.988 (Et first jet uncorrected = 57.6917)

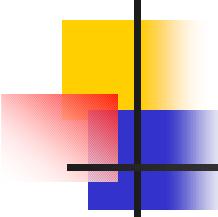
Et second jet = 30.4687 (Et second jet uncorrectd = 27.3702)

Emf 1st jet = 0.177992

Emf 2nd jet = 0.338102

η first jet = -0.446346

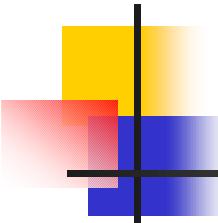
η second jet = -1.25196



Systematic uncertainties

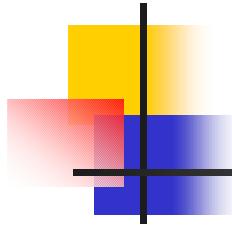
- Luminosity: 6%
- Acceptance
 - pdf 4.3% (from run I)
 - statistical error of MC 2.2%
 - jet energy scale (Level 3) 2.9 - 0.7 % (absolute uncertainty)
 - jets corrected for energy scale, time dependent and relative response
 - jet energy scaled of systematic uncertainty + 5% (energy scale + 5% data/MC adjustment);
- Electron ID efficiency (Z')
 - statistical error of $Z \rightarrow e^+e^-$ sample: 0.8%
 - energy scale : 3.7%
- Event vertex cut : 0.5% (Willis)

Final relative
uncertainty on
acceptance 9%



Cross section LIMIT

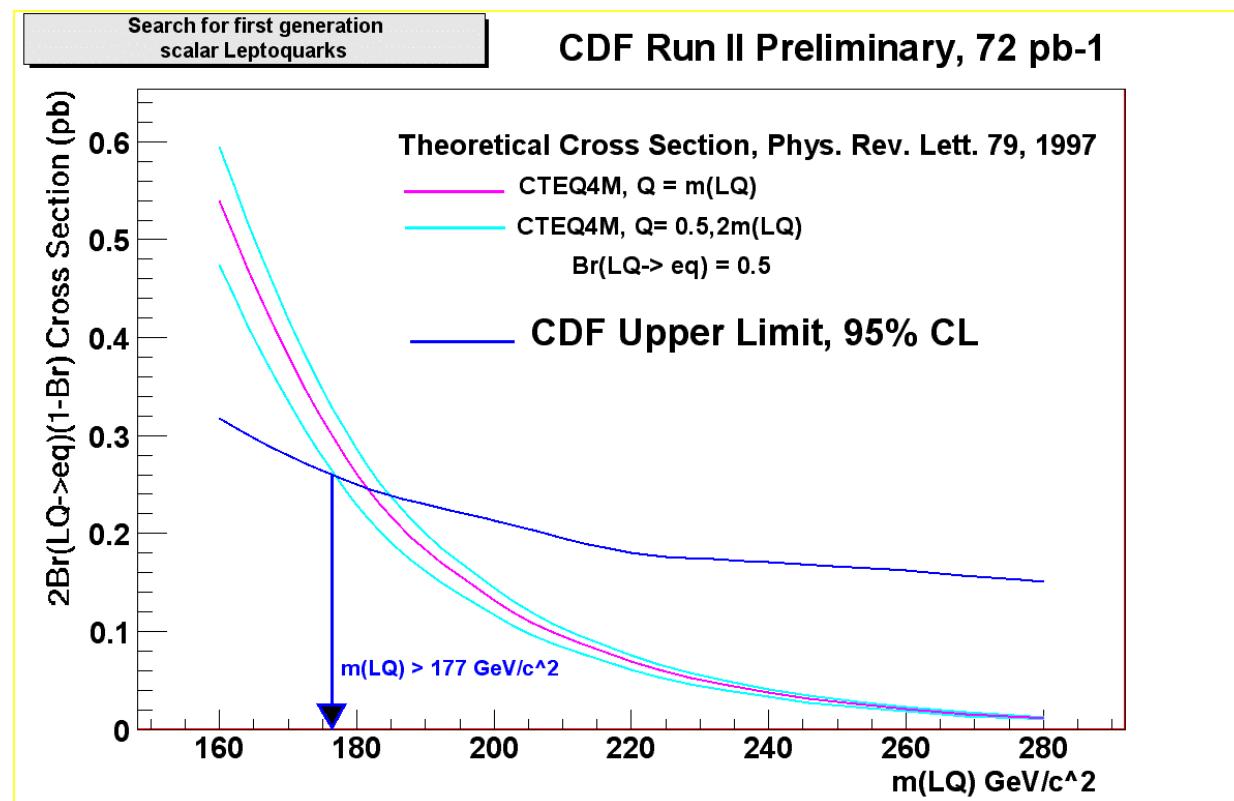
Mass	95%CL sigma (pb)	σ Theory CTEQ4M (pb) $Q^2 = M^2/4$	$Q^2 = 4M^2$
160	0.317289	0.595	0.474
180	0.250019	0.2855	0.229
200	0.213438	0.144	0.1165
220	0.180644	0.0755	0.061
240	0.170558	0.0407	0.03285
260	0.161803	0.0225	0.018
280	0.150269	0.01255	0.01



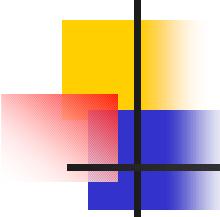
Number of events limit

Mass	95%CL nev (pb)	N Theory	CTEQ4M (pb)
		$Q^2 = M^2/4$	$Q^2 = 4M^2$
160	4.164	7.80858	6.22062
180	4.164	4.75492	3.81393
200	4.164	2.80932	2.27282
220	4.164	1.74034	1.40611
240	4.164	0.993649	0.801999
260	4.164	0.579037	0.46323
280	4.164	0.347765	0.277103

Cross section Limit



$M_{LQ} > 177 \text{ GeV} @ 95\% \text{ CL}$

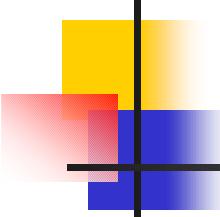


Conclusions

- A preliminary 95% CL cross section lower limit as a function of M_{LQ} , for leptoquarks decaying with 100% branching ratio into eq ($\beta = 0.5$) has been set.
- Comparing it to the NLO theoretical predictions for leptoquark pairs production at the TeVatron, an upper limit on the Leptoquark mass is obtained at

$$m_{LQ} > 177 \text{ GeV}/c^2$$

- consistent with run I limit at 182 GeV/c^2



Plans

- Bless this result and combine with eejj METjj for EPS
- Revise everything, with new software release, new dataset and increased Luminosity for LP